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THE RETENTION BY ELEMENTARY SCHOOL CHILDREN OF NATURAL SCIENCE MATERIAL TAUGHT BY TELEVISION.

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THE AIMS OF THIS PROJECT WERE TO STUDY THE RETENTION BY ELEMENTARY SCHOOL CHILDREN OF SCIENCE MATERIAL PRESENTED IN AN INTEGRATED PROGRAM OF SCIENCE TEACHING BY TELEVISION, AND TO STUDY THE CHANGES IN INTERESTS AND ATTITUDES TOWARD SCIENCE SUBSEQUENT TO THE PRESENTATION OF SUCH AN INSTRUCTIONAL PROGRAM. THE SUBJECTS WERE 1,600 FIFTH-GRADE STUDENTS. FOUR TESTS WERE EMPLOYED (TWO FOR SCIENCE ACHIEVEMENT AND TWO FOR ATTITUDES AND INTERESTS). DEPENDENT VARIABLES WERE SCIENCE ACHIEVEMENT (MEASURED BY MULTIPLE-CHOICE INFORMATION AND MATCHING VOCABULARY TESTS), SCIENCE ATTITUDE AND INTEREST, AND SCIENCE REASONING. CONCLUSIONS INDICATED--(1) STATISTICALLY SIGNIFICANT DIFFERENCES IN SCIENCE INFORMATION AND VOCABULARY GAINED BY THE TELEVISION STUDENTS OBSERVED BY THE END OF 1 YEAR OF INSTRUCTION WERE STILL EXISTING 4 AND 8 MONTHS LATER, (2) NO STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN CONTROL AND EXPERIMENTAL CLASSES WERE OBSERVED IN THE RETENTION OF SCIENCE MATERIAL OR OF SCIENCE INTEREST AND ATTITUDE CHANGES. BOTH GROUPS SHOWED A DROP IN SCIENCE INTEREST DURING THE COURSE OF THE EXPERIMENT. (JK)

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Author: Gerard T. Amirian

This research was conducted pursuant to a grant from the United States Office of Education, Department of Health, Education and Welfare, under provisions of Title VII of the National Defense Education Act of 1958.

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Principal Investigator: Ralph Garry

November 1, 1961

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I. THE RESEARCH PROBLEM

Purpose of the study

The purpose of this research was twofold: first, to study the retention by elementary school children of science achievement material presented in an integrated program of science teaching by television; and, secondly, to study the changes in interests and attitudes toward science consequent to the presentation of such a teaching program. To what extent were retention and changes in interests and attitude affected by teacher-training, method of presentation of program, and pupil activity; which combination of variables produced the optimum results in retention of science achievement material, which combination produced the most change in interests and attitudes toward science, and what was the direction of that change? These were some of the questions this study hoped to answer.

The use of various approaches within the same experimental framework carried on simultaneously made it possible to make comparisons of results and to determine statistically which combination of variables, if any, produced the best results. In other words, the structure of this research was such as to have made it possible to identify the most effective methods of the several employed.

Scope of the study

The two studies which preceded this one and for which this study of retention serves as a follow-up were those made by Doctors A. Cornelia Sheehan 1/ and Mary E. Kraft. 2/ Their subjects consisted of approximately 2600 children in 90 fifth grade classes randomly chosen from 300 available fifth grade classes of the public schools of 7 cities and 23 towns within a 50 mile radius of Boston. These children were presented with a series of thirty half-hour weekly natural science television programs designed by the staff of the Massachusetts Audubon Society and telecast over the open-circuit facilities of educational Channel 2,

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1/ A. Cornelia Sheehan. The Interrelationships of Interests and Attitudes and Specified Independent Variables in the Teaching of Natural Sciency by Television in the Fifth Grade. Unpublished doctoral dissertation, Boston University, 1960.

2/ Mary E. Kraft. A Study of Information and Vocabulary Achievement from the Teaching of Natural Science by Television in the Fifth Grade. Unpublished doctoral dissertation, Boston University, 1961.

WGBH-TV, Boston. The televised programs covered the period from October, 1959, through May, 1960.

This study of retention involved approximately 1600 of the 2600 children included in the two above-mentioned studies. For statistical purposes, a split-half method of testing was utilized. From each classroom, half of the children on whom complete data were available, were tested in October, 1960, while the other half was tested in February, 1961. From the end of May, 1960, to the beginning of October, 1960, and February, 1961, we have a lapse of 4 and 8 months, respectively. Thus this study of retention involved two periods onw of which was twice the distance in time as the other from the criterion, namely, the testing in May, 1960, against which retention was measured. Four tests were employed, two for science achievement and two for attitudes and interests. These were the same tests employed in May, 1960, thus making results entirely comparable. Statistical treatment was by analysis of variance made with the use of an IBM 650 Computer.

II. REVIEW OF RELATED RESEARCH

A survey of the literature revealed no intra-media studies of retention, or of attitudes and interest changes, at the elementary school level. The few studies of retention of material presented by television, or film, which have been made have generally been inter-media, or inter-group, studies--e.g., film vs. lecture, children vs. adults, et cetera. The survey would seem to indicate, therefore, that this study is the first intra-media study of retention reported.

To avoid duplication of material reviewed in the parent study, only material relevant to retention of achievement materials and to attitude and interest changes is presented here. (The results of the parent study, Grant Number 719008.09, were reported in a brochure prepared by Dr. A. Cornelia Sheehan, titled "Report of Research on the Integration of Science Teaching by Television into the Elementary School Program," and dated Boston University, October 31, 1960.)

In a book covering two decades of research in mass communications--via radio, television, comic strip, newspaper, etc.--its author, Joseph T. Klapper, 1/ makes this summary statement relative to attitude changes:

> "Communications research strongly indicates that persuasive mass communication is in general more likely to reinforce the existing opinions of its audience than it is to change such opinions. Minor attitude change appears to be a more likely effect than conversion and a less likely effect than reinforcement...." 2/

Furthermore:

> [He finds] "virtually no objective studies of the role played by mass communication in long term attitude change." 3/

Hideya Kumata's comprehensive review of television research discusses, primarily, work completed by colleges, universities, and the Armed Forces. 4/ He shows that (1) students do learn from TV and generally do as well and sometimes better than students learning by conventional instruction, (2) methods of teaching employed with TV made little difference in achievement results, (3) the role of attitudes in learning by television has not been

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1/ Joseph T. Klapper. The Effects of Mass Communication. Glencoe, Ill.: The Free Press, 1960.

2/ Ibid., p. 49.

3/ Ibid., p. 13.

4/ Hideya Kumata. An Inventory of Instructional Television Research. Ann Arbor, Michigan: Educational Television and Radio Center, 1956.

adequately studied, and (4) forgetting seems to be related to the amount learned rather than the medium used in the teaching.

Of further relevance to this study of retention are the studies of Knowlton and Tilton,1/ of Rulon, 2/ of Mullin, 3/ and the program "Instruction Film Research" sponsored by the Departments of Army and Navy (commenced in 1948), particularly Chapter III, Part III, "Long-time Retention of Knowledge from Films." 4/

The Knowlton and Tilton findings indicate that the contributions of films may be greater in immediate learning than in retention of material learned, but superior to non-film instruction in both. The Rulon findings indicate results somewhat contrary to these. Rulon compared the retention of information gained through the combines use of text plus films with that gained from the use of text only. He found that the superiority of the text-plus-films group over the text-only group was greater three and a half months after the film than it was immediately afterward.

In 1956, Daniel Mullin made a study of "Retention as a Function of Motivation and Environment in Educational TV on the Secondary School Level." The two environments treated in the study were the home and the classroom. The study covered a period of a little over two weeks and was based on a 50 multiple-choice item test in two forms administered to volunteer 11th graders in the public schools of New Orleans, Louisiana, after they had viewed a 23-minute educational TV program entitled "Exploration in Space." The immediate recall test was administered 24 hours after the telecast. The delayed recall was administered two weeks after the immediate recall. Two groups, one an unmotivated group and the other a motivated group, viewed the telecast in their homes while two other groups viewed it in school. Two additional groups were used as controls. Motivated viewing proved to be more effective than unmotivated in achieving greater retention at the .01 level of confidence. There appeared to be no differences in retention due to differences in environment. The mean scores suggest that the unmotivated student may learn more in the classroom than he does at home, and that the motivated student may learn more at home than he does in the classroom. Educational TV in the home, Mullin concludes, may be effective as part of the solution to the increasing shortages of teachers and classrooms.

1/ Instructional Film Research (Rapid Mass Learning), 1918-1950, Technical Report No. SDC. 269-7-19, Special Devices Center, Fort Washington, L.I., N. Y., Chap. III, Part III, pp. 3-9.

2/ Ibid., pp. 3-10.

3/ Mullin, Dissertation Abstracts, Vol. xvii, No. 6, 1957, p. 1414.

4/ Instructional Film Research, Chap. III, Part III, pp. 3-11.

This summary statement on "Long-time Retention of Knowledge from Films" is found in Instructional Film Research.

> "There is nothing in a motion picture presentation, per se, that guarantees better learning. Some films do not add to the effectiveness of usual methods of teaching, and some may even be worse than the usual methods. Merely to use any film or any filmstrip does not make a better teacher, or insure more learning by the pupils. The instructional value of a given film depends upon many factors.... If films merely repeat material that is usually presented by the instructor or the text, they may contribute little or nothing additional to the learning. On the other hand, the facts seem to show that when the film and text, or film and class teaching are mutually reinforcing and supplementary, and not merely repetitious, learning does take place. Moreover, when films are used to supplement usual teaching methods, their effectiveness is more pronounced as an aid to retention than to immediate learning." 1/

1/ Ibid., pp. 3-11.

III. PROCEDURE

Test construction

To various members of the research staff of both the parent study and this study of retention fell the responsibility of constructing tests suitable for the purposes of this research. In order that results might be comparable, the four tests used in this study of retention were the same as those used in the parent study. They consisted of an Attitude Scale, an Interest Inventory, a Science Information Test, and a Science Vocabulary Test.

The object of the Attitude Scale was to make a comparison of the pupils' perception of the scientist with the scientists' own perception of themselves as scientists as determined by a survey made by Dr. Sheehan of 100 physical, 100 natural-biological, and 100 social scientists. The Scale consisted of 60 statements prefaced by the phrase "A SCIENTIST IS SOMEONE WHO ....," to each of which the pupils answered either True, False, or Don't Know. Shifts in perception were then related to prevailing attitudes in the child and adult populations.

The object of the Interest Inventory was to inventory the expressed interests of children in each of 5 areas: Science, Mechanical, Athletic, Literary, and Humanitarian. The final form of this test produced a reliability of .97 as per Kuder-Richardson formula and consisted of 40 sets of triads of forced choices in which 40 science interest items were paired alternately with 20 each of Athletic- , Mechanical- , Humanitarian- , and Literary-interest items. The test was analogous in design and function to the Kuder Vocational Preference Inventory (Science Research Associates), and the items selected were those considered pertinent to the age level of the children in the study.

Preliminary forms of a Science Information Test were administered to 650 fourth, fifth, and sixth grade children. On the basis of an item analysis of the results, a final form was evolved consisting of 75 items cast in a multiple-choice form of presentation, with each item having a four choice possibility with but one correct choice among them. Final selection of items depended upon a regard for proper coverage of informational outcome as well as for proper distribution of difficulty and discrimination of the items chosen. Reliability of the final form, obtained by the split-half method and based on results of administering the test to 102 subjects, was .74. When corrected for attenuation by the Spearman-Brown formula, a reliability of .86 was obtained. Validity was determined by a combination of the judgment of three experts--all members of the Massachusetts Audubon Society's educational staff who produced the TV series, by content analysis, and by statistical analysis.

The Science Vocabulary Test final form, arrived at after the construction of two preliminary forms and their experimental try-out on 235 children in the fourth, fifth, and sixth grades,

consisted of 150 words. The pupils were asked to associate each of the 75 words of Part I with one of 5 categories, namely: Animals; Birds; Flowers; Rocks; ores, gems, and Trees. The 75 words of Part II, on the other hand, were to be associated with broader categories, including 2 biological processes among them. These categories were: Plants, Vertebrates, Invertebrates, Nutrition, and Reproduction. As was the case in the Information Test, final selection was based on distribution of item difficulty, level of discrimination, and the approval of the subject-matter experts. Validity of the test was based on content analysis of the subject-matter area to be tested, on the judgment of three experts in the field of natural science, and on the statistical analysis of individual items. Reliability was based on an analysis of the results of administering the test to a sample of 120 subjects. Correlation for two equavalent halves was .96. Using the Spearman-Brown formula for estimating reliability when a test is doubled, a correlation of .98 was obtained for the whole test.

The experimental design

Figure 1 presents a diagram of the experimental design.

	Initiating Activity	Terminating Activity	
Study Guides	18 classes	18 classes	36
Independent Activity	18 classes	18 classes	36
	36	36	72

Fig. 1. A Diagram of the Experimental Design

Arrangement of classes within each cell were as follows:

6 classes - Science-trained teachers
- 3 - individual pupil activities
- 3 - common class assignment

6 classes - TV-trained teachers
- 3 - individual pupil activities
- 3 - common class assignment

6 classes - No special teacher training
3 - individual pupil activities
3 - common class assignment

Independent variables

The four designated independent variables operating within the experimental design were:

1 a. TV-Initiating. Here, the TV telecast preceded classroom science activities. TV viewing acted as a stimulator of interest.

b. TV-Terminating. Here, science activities preceded TV viewing. TV served to clarify concepts and provide information on topics to which the class had already been studying.

2 a. Study Guide. This extensive guide was printed and distributed by the 21" CLASSROOM for use in conjunction with the natural science series EXPLORING NATURE. It provided the teacher with essential information on the content of each program with questions for discussions and suggestions for projects. Those teachers who fell within the Study Guide classification of the experimental design were asked to use this guide as a source book in their science instruction for their classes.

b. Independent Activity. Teachers falling within this classification received a 21-page resumé of the natural science television programs and were asked to use their initiative and imagination in utilizing any source material they desired with regard to the programs to be viewed and the topics to be covered.

3 a. Science-trained Teacher. Teachers in this category took part in a natural science television workshop which consisted of an intensive program covering major biological principles. Emphasis was on the elementary school science program and on projects suitable for elementary school children. Field trips in local areas followed the three-day workshop in order to familiarize teachers with the local resources available.

b. TV-trained Teacher. Teachers in this category took part in a workshop designed to familiarize them with the utilization of the medium of television as a teaching aid.

c. No Special Teacher Training. Teachers in this category did not participate in either of the two workshops mentioned above.

4 a. Individual Pupil Activities. The pupils in classes falling under this designation were encouraged, either alone or in pairs or trios, to choose topics of interest to them. These topics were then treated as their individual science projects.

b. Common Class Assignment. Pupils in classes falling under this designation were all assigned the same topic for study. They were permitted to use different means with respect to the

topic assigned, e.g., drawings, talks, models, etc., but all worked on the same topic.

Population

In September, 1960, the 2600 coding sheets of pupils involved in the parent study were surveyed to identify those which had complete data on the four tests used in this study of retention. Where a class had more than 20 pupils with complete data as here specified, only the first 20 were used. Thus, the sample for this study of retention consisted of approximately 1600 pupils.

Testing schedule

Within each classroom, participating pupils were divided into two groups, with one group being designated for October, 1960, testing, and the other for February, 1961, testing. Thus, for statistical purposes, the split-half method was employed so that those tested in October could later be compared with those tested in February with reasonable assurance of the equivalence of the two groups being compared.

Treatment of data

The analysis of variance to which the data was subjected fell into three major groupings. These were as follows:

1. An analysis of controls versus experimentals. In the original study 72 classes had been randomly assigned to an experimental category (see Fig. 1). The remaining 18 classes served as control. The control classes viewed the TV programs, but engaged in original follow-up activity. In this phase of statistical analysis, all control subjects were compared with all experimental subjects. This was followed by a comparison of all control subjects, male, with all experimental subjects, male, and then again the same for females. In all of these comparisons, an analysis of variance was made between the May and October testing, and then again between the May and February testing. Mean difference scores were used. The class served as the unit of measure with the class mean considered its score. The analysis was carried out for all four of the tests in turn.

2. A comparison of I.Q. quarters. This phase of the study aimed to discover statistically significant differences, if any, between the different I.Q. quarters of the controls when results of the May testing were compared with those of October. This process was repeated for the May and February testing also. This total process was again repeated for experimental subjects. In this analysis of I.Q. quarters, the scores used were the mean scores of each I.Q. quarter. Again, as in the previous group, the analysis was carried out for all four of the tests in turn.

3. Four-way analysis. Here, the four main effects of the experimental design, namely, TV, Guide, Training, and Assignment, and their interaction, were analyzed for statistical significance. Only experimental classes could be used in this analysis. Data were analyzed for variance between the May and October testing, and then again between the May and February testing. Analysis was by class, and then by class by sex, male and female taken in turn. Mean difference scores were used, with the class serving as the unit of measure and the mean of the class considered its score. All four tests were subjected to this total analytic process in turn.

IV. ANALYSIS AND INTERPRETATION OF DATA

1. Analysis of control versus experimental groups.

Analysis of variance between control and experimental groups and their male and female components produced no significant F values for any of the four tests used. With 1 and 88 degrees of freedom, an F value of 3.95 was required for significance at the 5% level of confidence. None of the F values obtained were that large (see Tables 1, 2, and 3 below). This indicated that the experiment as a whole did not affect significantly the retention of science achievement material and of science attitude and interest changes.

TABLE 1. ANALYSES OF VARIANCE BETWEEN CONTROL AND EXPERIMENTAL GROUPS USING MEAN DIFFERENCES BY CLASS

Dependent Variable	Test Period	Source of Variation	df	M.Sq.	F	Statistic	Control N=18	Exper. N=72	Total N=90
Sci.Info.	May-Oct.	Between	1	31.41	3.02	M.Diff.	2.84+	1.36+	1.66+
		Within	88	10.41		S.D.	2.97	3.24	3.24
	May-Feb.	Between	1	18.21	1.29	M.Diff.	4.01+	2.89+	3.11+
		Within	88	14.06		S.D.	2.40	3.96	3.73
Sci.Vocab.	May-Oct.	Between	1	44.28	.82	M.Diff.	5.21+	3.46+	3.81+
		Within	88	53.81		S.D.	9.22	6.66	7.28
	May-Feb.	Between	1	37.68	.50	M.Diff.	4.07+	2.45+	2.78+
		Within	88	75.74		S.D.	8.81	8.55	8.63
Sci.Atti. (Part II-B)	May-Oct.	Between	1	3.36	.50	M.Diff.	.53-	.05-	.14-
		Within	88	6.70		S.D.	2.40	2.59	2.56
	May-Feb.	Between	1	9.22	1.53	M.Diff.	1.14+	.34+	.50+
		Within	88	6.03		S.D.	2.38	2.43	2.44
Sci.Int.	May-Oct.	Between	1	.14	.06	M.Diff.	.60-	.50-	.52-
		Within	88	2.39		S.D.	1.81	1.45	1.53
	May-Feb.	Between	1	2.49	.50	M.Diff.	1.25-	.83-	.92-
		Within	88	5.01		S.D.	2.28	2.19	2.21

TABLE 2. ANALYSES OF VARIANCE BETWEEN CONTROL AND EXPERIMENTAL GROUPS USING MEAN DIFFERENCES BY CLASS BY SEX (MALE)

Dependent Variable	Test Period	Source of Variation	df	M.Sq.	F	Statistic	Control N=18	Exper. N=72	Total N=90
Sci.Info.	May-Oct.	Between	1	40.04	2.18	M.Diff.	3.35+	1.68+	2.01+
		Within	88	18.34		S.D.	3.49	4.39	4.28
	May-Feb.	Between	1	.01	.00	M.Diff.	2.82+	2.84+	2.83+
		Within	88	21.56		S.D.	3.41	4.84	4.59
Sci.Vocab.	May-Oct.	Between	1	.65	.01	M.Diff.	3.10+	3.32+	3.27+
		Within	88	60.74		S.D.	9.97	7.02	7.70
	May-Feb.	Between	1	17.64	.17	M.Diff.	3.62+	2.52+	2.74+
		Within	88	103.21		S.D.	11.96	9.50	10.05
Sci.Att. (Part II-B)	May-Oct.	Between	1	6.59	.72	M.Diff.	.86-	.19-	.32-
		Within	88	9.12		S.D.	3.21	2.92	2.99
	May-Feb.	Between	1	.90	.08	M.Diff.	.65+	.40+	.45+
		Within	88	10.63		S.D.	3.70	3.09	3.22
Sci.Int.	May-Oct.	Between	1	.02	.00	M.Diff.	.68-	.64-	.65-
		Within	88	7.52		S.D.	3.52	2.46	2.71
	May-Feb.	Between	1	3.03	.34	M.Diff.	.27-	.73-	.63-
		Within	88	8.93		S.D.	2.72	3.01	2.96

TABLE 3. ANALYSES OF VARIANCE BETWEEN CONTROL AND EXPERIMENTAL GROUPS USING MEAN DIFFERENCES BY CLASS BY SEX (FEMALE)

Dependent Variable	Test Period	Source of Variation	df	M.Sq.	F	Statistic	Control N=18	Exper. N=72	Total N=90
Sci.Info.	May-Oct.	Between	1	1.76	.98	M.Diff.	2.13+	1.02+	1.24+
		Within	88	1.80		S.D.	4.46	4.12	4.22
	May-Feb.	Between	1	60.49	2.87	M.Diff.	4.87+	2.82+	3.23+
		Within	88	21.06		S.D.	3.46	4.76	4.61
Sci.Vocab.	May-Oct.	Between	1	9.49	.84	M.Diff.	6.59+	4.02+	4.54+
		Within	88	11.29		S.D.	12.68	9.88	10.55
	May-Feb.	Between	1	61.91	.65	M.Diff.	4.47+	2.40+	2.82+
		Within	88	95.54		S.D.	9.17	9.78	9.70
Sci.Att. (Part II-B)	May-Oct.	Between	1	.09	.01	M.Diff.	.08-	.01-	.02-
		Within	88	11.49		S.D.	2.37	3.55	3.35
	May-Feb.	Between	1	28.36	2.36	M.Diff.	1.93+	.52+	.81+
		Within	88	12.01		S.D.	2.57	3.60	3.47
Sci.Int.	May-Oct.	Between	1	16.00	2.76	M.Diff.	1.13-	.08-	.29-
		Within	88	5.79		S.D.	1.92	2.48	2.41
	May-Feb.	Between	1	8.90	1.07	M.Diff.	1.78-	1.00-	1.15-
		Within	88	8.34		S.D.	2.98	2.82	2.87

Though no significant F values were produced, an inspection of mean differences did, however, show an increase in information and vocabulary scores for both control and experimental groups, with increases favoring the controls more than the experimentals. Inasmuch as this is a study of retention, the question arises as to how one can retain more than one knew four and eight months earlier. This might be explained by making the following observation. The end of the experiment did not mean the end of learning for pupils. With growth and additional experience through normal exposure in their everyday lives, both in and out of school, to various aspects of science generally, it was reasonable to expect that these children, controls and experimentals alike, should show an increase in their store of factual science knowledge. The generally greater increases in the achievement scores of control groups may possibly be explained by stating that the experimental groups, subjected as they were to an intensified program of natural science throughout most of the previous school year, found their forward momentum slacking off once the prop of the experimental experience was removed from under them. The controls, on the other hand, kept moving along at their accustomed rate with the result that a comparison of the May and the subsequent retention test results revealed tendencies in rate of movement favoring the controls, as logical considerations should have led one to expect.

In the attitude test, the mean differences revealed a drop in October followed by a general increase by February. This was true for both boys and girls. Sheehan's study showed that the attitudes were not easily changed, at least by factual information about science seen on television. Speculating about non-significant differences has its dangers but possibly the indrease indicates that the pupils' concept of the scientist was becoming clearer and more in line with reality. Additional experience and an increase in his knowledge of science may have been responsible for this move toward a clearer perception of the scientist.

The interest test results revealed a drop in science interest for all groups for both periods of testing, with the drop being generally greater for February than for October and greater for females than for males. The investigators had been somewhat dismayed to discover a loss in interest occurring at the end of the initial studies--not for all pupils but for classes taken as a whole. The TV programs had been interesting if holding the attention of pupils is a gauge; the participation by students in science had been generally enthusiastic. Speculations were raised as to whether the drop in interest represented the effect of a reality experience or if it came as a result of making schoolwork of an otherwise interesting subject. If the effect was a reality effect we ventured a guess that interests would remain lower, but if either a saturation effect or a schoolwork effect, some recovery should be noted over the summer.

2. Analysis by I.Q. quarters.

Tables 4, 5, 6, and 7 present the results of analyses using mean scores of I.Q. quarters as the unit of measure.

TABLE 4. MEAN VALUES OF ACHIEVEMENT SCORES BY I.Q. QUARTERS

Source of Variation		Mean Values							
		Sci. Information				Sci. Vocabulary			
		May	Oct.	May	Feb.	May	Oct.	May	Feb.
CONTROL	(Hi)Q1	30.57	34.08	29.66	34.43	79.24	87.08	83.51	89.09
	Q2	19.39	22.39	20.71	24.24	50.89	60.47	55.62	58.29
	Q3	17.82	20.13	16.06	20.15	47.63	51.89	47.44	52.79
	(Lo)Q4	10.61	13.05	11.11	14.91	35.16	35.42	31.91	33.83
EXPERIM.	(Hi)Q1	38.47	39.91	36.36	39.18	93.44	99.25	93.89	98.66
	Q2	30.76	32.02	30.83	33.55	75.61	78.98	76.61	80.19
	Q3	25.97	27.99	26.63	29.19	62.00	66.67	66.18	68.68
	(Lo)Q4	18.87	19.56	17.16	20.46	49.71	50.29	46.58	46.17

TABLE 5. ANALYSES OF VARIANCE OF ACHIEVEMENT SCORES USING MEANS BY I.Q. QUARTERS

Source of Variation		F Values			
		Sci. Information		Sci. Vocabulary	
		May-Oct.	May-Feb.	May-Oct.	May-Feb.
CONTROL	Groups	40.36**	35.96**	36.18**	44.95**
	Trials	19.94**	51.58**	14.23**	8.62**
	G x T	.19	.23	2.03	.50
EXPER.	Groups	118.14**	110.13**	124.87**	137.78**
	Trials	21.83**	71.69**	46.89**	21.84**
	G x T	.89	.30	4.57**	3.96**

** F significant at .01 level of confidence.

TABLE 6. MEAN VALUES OF ATTITUDE AND INTEREST SCORES BY I.Q. QUARTERS

Source of Variation		Mean Values							
		Sci.Attitude (Part II-B)				Sci. Interest			
		May	Oct.	May	Feb.	May	Oct.	May	Feb.
CONTROL	(Hi)Q1	12.65	13.14	13.86	16.49	12.32	11.00	13.54	11.94
	Q2	14.13	14.47	13.85	14.50	10.87	9.63	12.06	10.65
	Q3	13.50	12.13	14.56	15.35	12.89	11.87	12.41	11.44
	(Lo)Q4	13.66	12.82	14.66	14.77	11.76	12.29	12.17	11.86
EXPERIM.	(Hi)Q1	15.58	16.47	15.32	16.62	14.16	13.18	13.19	12.40
	Q2	13.55	13.69	14.61	15.14	12.31	12.10	12.83	11.87
	Q3	14.34	13.66	15.45	14.97	12.63	12.29	12.74	11.37
	(Lo)Q4	14.53	14.04	14.48	14.68	12.62	12.37	12.98	12.78

TABLE 7. ANALYSES OF VARIANCE OF ATTITUDE AND INTEREST SCORES USING MEANS BY I.Q. QUARTERS

Source of Variation		F Values			
		Sci.Att.(Part II-B)		Sci. Interest	
		May-Oct.	May-Feb.	May-Oct.	May-Feb.
CONTROL	Groups	.85	.30	1.23	.48
	Trials	.79	6.25*	3.40*	7.22**
	G x T	1.31	1.71	1.11	.52
EXPER.	Groups	6.71**	2.37	2.44	.69
	Trials	.01	2.71	7.15**	16.14**
	G x T	1.65	2.48	1.20	1.38

** F significant at .01 level of confidence.
* F significant at .05 level of confidence.

In the analysis by I.Q. quarters, the .01 level of confidence for groups for both information and vocabulary indicates that intelligence is an important factor in the retention of science achievement materials. High I.Q. groups perform significantly better than those with low I.Q.'s. The .01 level of confidence for trials indicates that retention is affected by the interval intervening between one testing period and the next. Of the four possible interaction effects possible between groups and trials the only one of significance was with the vocabulary test for experimental subjects.

An inspection of the means of I.Q. quarters indicates gains in both information and vocabulary for both control and experimental groups, with gains for controls generally greater than those for experimentals. In Table 4, the greater variation in means by I.Q. quarters for the experimental group suggests better provision for individual differences, in contrast with the control groups wherein the two mid-quarters show similar scores.

Analysis by I.Q. quarters reveals no significant interaction effects for either attitude or interest for either the controls or the experimentals. This indicates that I.Q. was not affecting the changes in science attitude or interests which were significantly different from each other from one testing period to the next. When groups were pooled over trials, however, analysis of science interest produced trial effects which were significant for both control and experimental subjects for both periods of testing, indicating significant changes in interest from one test period to the next.

An inspection of the means of I.Q. quarters of the attitude test indicates that from May to October the two upper quarters of both the control and experimental groups advanced over their May scores while the two lower quarters declined. By February, however, all quarters of both groups, excepting the third quarter of the experimentals, had advanced over their May scores. An inspection of the means of I.Q. quarters of the interest test shows that, excepting the lowest quarter of the May to October testing of control subjects, a general drop of interest in science was experienced by all groups.

3. Four-way analysis.

Tables 8 and 9 present all the F values arrived at by four-way analysis of the four main effects of the experimental design and their interaction. Table 10 shows the 12 significant results obtained and a further analysis to determine the combination of factors responsible for the changes in retention.

TABLE 8. FOUR-WAY ANALYSIS OF VARIANCE OF ACHIEVEMENT GAINS BY MEAN DIFFERENCE SCORES FOR EXPERIMENTAL CLASSES, MAY TO OCTOBER AND MAY TO FEBRUARY TESTING PERIODS

Variables and Interactions	F Values											
	Science Information						Science Vocabulary					
	May - Oct.			May - Feb.			May - Oct.			May - Feb.		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
TELEVISION	.77	.27	.56	.40	1.15	.30	2.93	.13	1.55	1.50	1.11	.09
GUIDE	.12	.61	.27	.29	.26	.05	.29	.66	.29	5.39*	.01	1.95
TRAINING	.38	2.37	1.06	.35	.29	.23	.95	1.38	1.46	1.28	.05	.37
ASSIGNMENT	.20	2.43	.19	1.52	.03	.41	.80	.04	1.01	.00	.17	.28
TV x G	.08	.07	.10	1.77	4.80*	5.25*	3.64	.40	1.45	1.78	.28	.74
TV x Tr	.66	.77	1.71	.28	.33	.03	.24	.31	.83	3.02	.66	2.15
TV x A	.25	.06	.24	3.82	.38	1.81	.01	1.95	.86	.72	.22	.11
G x Tr	.07	1.48	.88	.80	.19	.57	.06	.49	.12	2.74	.43	1.65
G x A	1.71	.31	3.03	5.41*	.01	1.96	1.65	1.39	1.53	.34	2.43	1.23
Tr x A	.80	1.99	.48	1.70	2.42	.58	.56	1.55	.70	.76	1.32	.56
TV x G x Tr	1.55	1.07	2.61	.89	.76	1.35	.44	2.45	1.76	1.94	.03	.34
TV x G x A	.40	.05	.49	3.72	.18	.55	.33	2.54	.49	.44	1.44	.14
TV x Tr x A	1.37	1.47	2.11	.70	.28	.99	2.29	.57	.77	1.92	1.37	1.63
G x Tr x A	.25	2.09	1.01	.49	1.80	1.54	.31	.19	.20	1.69	1.99	1.23
TVxGxTrxA	1.48	2.28	1.36	3.61*	.18	.66	1.75	2.81	1.83	.12	.37	.55

* F significant at the .05 level of confidence.

TABLE 9. FOUR-WAY ANALYSIS OF VARIANCE OF CHANGES IN SCIENCE INTEREST AND ATTITUDES (PART II-B: PERCEPTION OF THE SCIENTIST) BY MEAN DIFFERENCE SCORES FOR EXPERIMENTAL CLASSES, MAY TO OCTOBER AND MAY TO FEBRUARY TESTING PERIODS

Variables and Interactions	F Values											
	Science Attitude						Science Interest					
	May - Oct.			May - Feb.			May - Oct.			May - Feb.		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
TELEVISION	.70	.07	.00	.01	.11	.33	.35	.62	.11	.29	1.10	.31
GUIDE	.23	.01	.25	.94	.88	.15	.01	.18	.23	.79	2.09	1.90
TRAINING	.25	1.10	.37	2.66	2.82	3.09	.09	.12	.09	2.24	2.66	.84
ASSIGNMENT	.47	1.04	.00	5.71*	9.44**	10.42**	.51	.59	.00	.00	.62	.13
TV x G	.02	4.92*	1.69	.17	.00	.22	.07	.25	.64	.05	.22	.16
TV x Tr	.12	1.66	.58	1.17	.16	.27	.02	.56	.06	.85	.72	1.04
TV x A	.66	.00	.02	2.96	1.19	3.52	.79	1.20	.06	.50	.89	.57
G x Tr	2.22	.82	1.04	1.23	1.85	1.39	1.07	5.75**	1.32	.13	.92	.23
G x A	.07	1.54	.68	.03	.00	.23	.00	2.36	.50	.60	2.24	.05
Tr x A	1.51	1.64	.30	1.41	.58	.28	1.68	.48	.25	.58	3.33*	1.55
TV x G x Tr	.29	3.18	1.51	2.06	.96	1.19	.87	.11	.50	1.30	.14	.55
TV x G x A	.06	.18	.00	.46	.20	.12	1.11	1.24	.45	.15	.18	.59
TV x Tr x A	1.24	.53	.10	1.31	.64	.27	.48	.11	.30	.09	.87	.55
G x Tr x A	.01	1.74	.76	1.86	2.35	1.34	.48	.29	.43	.74	.52	1.17
TVxGxTrxA	1.41	.57	.98	3.33*	.65	1.99	.32	1.07	.66	.50	.49	.13

** F significant at the .01 level of confidence.
* F significant at the .05 level of confidence.

With respect to science information, four-way analysis of variance of experimental classes and their male and female components produced no significant F values for any of the four main effects of the experimental design. This indicates that the temporal position of television, whether initiating or terminating, does not affect the retention of science information material to any appreciable degree. Neither does the use nor non-use of study guide, nor the influence of any of the three teacher-training categories, nor the kind of assignment given, whether individual or class, produce significant differences in retention. As for interaction effects, four-way analysis did produce four significant results. Of these four, two involved television and study guide. Television as initiating activity in interaction with the use of study guide produced the direction of greatest gain in both cases, one of which involved girls while the other involved the total class (see Table 10). The most probable explanation is that these are significant F values obtained by chance. When the number of statistical tests is large, a fraction will attain a statistical level of significance.

The original study showed that the interaction of order of presentation of program and type of pupil activity had significant effect upon science achievement. This finding does not hold for retention.

Four-way analysis of science vocabulary produced only one significant F value, that for Guide, involving boys only. Further analysis revealed that the greater gain was achieved when a study guide was not used, that is to say when an independent course of activity was followed instead. The general absence of significant F values for vocabulary in these four-way analyses implies that the gains in vocabulary were not a function of variations in experimental treatments.

Four-way analysis of variance for science attitude produced five significant F values, two of them at the .01 level of confidence. The most important finding involved the use of assignment. Assignment was significant at the .05 level for boys, and at the .01 level for girls and for total. Analysis revealed that the use of class assignments produced more realistic attitudes for all three classifications while the use of individual assignments produced less. Whether or not there are chance variations occurring in a large number of statistical tests is difficult to determine. It may be that common assignments contribute to a more uniform perception of the scientist. Support gained through mutual involvement with their peers in common class assignments may create less confusion about scientists.

Four-way analysis of variance of science interest produced two significant F values, one of them significant at the .01 level of confidence. Both involved girls. Guide and training interacted within the May to October period to produce an effect on girls which was significant at the .01 level of confidence, however, this did not hold for the February testing.

TABLE 10. THE TWELVE SIGNIFICANT RESULTS OF TABLE 6 AND TABLE 7 ANALYZED TO DETERMINE COMBINATION OF FACTORS RESPONSIBLE FOR VARIATIONS IN RETENTION

Significant Result	Greatest Gain	Least Gain (losses are so indicated)
Science Information		
TV x G, May-Feb.,Girls	TV Init. x Guide	TV Init. x No Guide
TV x G, May-Feb.,Total	TV Init. x Guide	TV Term. x Guide
G x A, May-Feb., Boys	NoGuide x Class Assign.	NoGuide x Ind. Assign.
TVxGxTrxA,May-Feb.,Boys	TVInit.xNoGxTVTrxClassA	TVTerm.xGxSc.TrxClassA(loss)
Science Vocabulary		
Guide, May-Feb., Boys	No Guide	Guide
Science Attitude		
TV x G, May-Oct.,Girls	TVTerm.xNoGuide	TVInit.xNoGuide(loss)
Assign.,May-Feb.,Boys	Class Assign.	Indiv. Assign. (loss)
Assign.,May-Feb.,Girls	Class Assign.	Indiv. Assign. (loss)
Assign.,May-Feb.,Total	Class Assign.	Indiv. Assign. (loss)
TVxGxTrxA,May-Feb.,Boys	TVInit.xNoGxTVTrx ClassA	TVInit.xNoGxNoTrxIndiv.A(loss)
Science Interest		
G x Tr,May-Oct.,Girls	NoGuide x TV Tr.	NoGuide x Science Tr.
Tr x A, May-Feb.,Girls	TVTrain. x Ind.Assign.	TVTrain. x ClassAssign.(loss)

Inspection of Table 10 reveals no consistent pattern of effects or interaction of the experimental variables of order of presentation, teacher training, instructional guide, or pupil assignment on retention of science information and vocabulary or changes in attitude and interest.

V. SUMMARY AND CONCLUSIONS

Summary

This study of retention of science information and stability of changes in attitude and interest toward science is a follow-up of a study which concerned itself with the teaching of natural science by television to fifth grade children. Thirty half-hour programs, prepared by the Massachusetts Audubon Society on natural science were broadcast weekly during the school year 1959-60 to the communities participating in "The 21" Classroom."

In the parent study, 72 fifth grade classes randomly drawn from a pool of 300 classes in 30 communities were randomly assigned to one of 24 experimental treatments resulting from combinations of the following four independent variables:

1. Order of presentation of program. In half of the classes the program preceded class activity; in half class activity on topic preceded viewing of programs. Variation by block of programs and by individual program for each class.

2. Study guide. Half of the teachers were provided an extensive study guide which served as a source book about information contained in the programs, experiments, etc.; half of the classes had a brief resume of programs only and were responsible for using their own resources in connection with the programs.

3. Teacher training. Classroom teachers were divided into three groups and provided workshop training: (1) natural science, (2) utilization of television, (3) no special training.

4. Pupil assignment. Pupils in half of the classes were encouraged to work on individual assignments chosen by themselves; in other half the pupils were given a common assignment by the teacher.

Dependent variables were science achievement measured by multiple-choice information and matching vocabulary tests, science attitude and interest, and science reasoning. In the present study all but the last variable were studied.

Complete data were available for 1600 of the 2600 pupils in the original study in the 72 experimental classes and the 18 randomly drawn classes in the control group. These 1600 pupils were divided in two and one-half were tested in October of 1960, four months after terminal testing in the original study, and the second half tested in February of 1961 after an interval of eight

months. Analysis of variance was employed to test for differences in retention of science achievement, interest, and attitude associated with the independent variables. The mean score of each class served as the unit, hence N = 90.

Science Information

Analysis of variance between control and experimental groups, by group and by sex, produced no significant F value, indicating that the experimental variables did not yield significant variation in retention of science information. An inspection of mean differences did show an increase in information scores for both control and experimental groups, with the increases favoring the controls. (In the original study, experimental groups had shown significantly greater gains than control, hence control groups started at a lower point. In spite of the gain, control groups still differ significantly from experimental groups in science achievement.)

Analysis by I.Q. quarters shows statistically significant differences for both groups and trials indicated greater retention for higher I.Q. groups and significant gains over the time periods between terminal and retention testing.

On a four-way analysis no significant results were obtained for any of the main effects, and the four statistically significant interaction effects reflected no meaningful pattern.

Science Vocabulary

Results similar to those obtained for Science Information were observed with respect to vocabulary. Statistically significant gains over the intervening time period and greater for higher I.Q. groups.

Science Attitude

No significant differences observed in a comparison of scores of control and experimental groups. Changes in attitude occurring during the experimental year were observed to be linked to peer group and adult value systems. Perception of the scientists (resulting from a comparison of pupil perception with self-perception of scientists) shows an initial decrease during the four month retention interval but an increase towards more realistic perception over the longer time period.

In the four-way analysis of variance, five F values reached .05 or .01 level of significance and suggest that common class assignments yield more realistic perception of scientists than individual assignments.

Science Interest

Comparison of control and experimental groups, by group and by sex, discloses no statistically significant differences over either the four or eight month intervals. Both groups show a statistically significant drop in interest for both periods, with the drop being greater the longer the interval. Changes were equivalent for all I.Q. levels, although tending to be greater at higher I.Q. levels.

Conclusions

1. The gains in science information and vocabulary occurring during the original study of television instruction in science were retained and increased over the intervening four and eight month intervals used in this study of retention. The statistically significant differences observed by the end of the year of instruction were still existing four and eight months later.

2. The study of retention as a whole produced no statistically significant differences between control and experimental classes or their male and female components in the retention of science achievement material and of science interest and attitude changes. Media and methods used in the teaching situation in this study, it may be concluded, bore no significant relationship to the psychological process of retention. They may have helped learning, but once learning had occurred, the process of retaining and forgetting proceeded on a different basis.

3. An inspection of means and mean differences indicated an increase in information and vocabulary scores for both control and experimental groups, with increases favoring the controls more so than the experimentals, and high I.Q. quarters more so than the low. The increases in retention were explained by making the general observation that the end of the experiment did not mean the end of learning for the pupils. Normal exposure in their everyday lives to various aspects of science generally help increase pupils' store of factual science material. The greater increase for controls over experimentals was attributed to the change in momentum experienced by the experimentals once the prop of the experimental design was removed from under them. The greater increase for high I.Q. quarters was attributed to their intelligence. The more intelligent person learns more than the less and retains more of what he learns.

4. The end of the study found no significant differences among I.Q. groups in attitude and interest changes when control and experimental subjects were compared. This would seem to indicate the limitations, at present, of educational methods in systematically developing and engendering changes in attitudes and interests. The effective control and direction of attitudes and interests may have to wait till more is known about their psychological aspects or instructional methods are adapted to make use of what is known.

5. The general drop in science interest for all groups for both periods of testing, as revealed by an inspection of mean differences, with interest of females dropping more than those of males, and that of high I.Q. groups dropping more than that of the low, gave rise to several hypotheses:

(1) Differential effects associated with sex differences in sexual maturation.

(2) Saturation effect.

(3) Making school work out of a pleasurable recreational activity.

(4) Reality effect. The decline and non-recovery of scores lends support to the first and last hypotheses more than the second and third.

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